Cobalt

CAS No. 7440-48-4

General Information

Cobalt is a magnetic element that occurs in nature either as a steel-gray, shiny, hard metal or in combination with other elements. The cobalt used in U.S. industry is imported or obtained by recycling scrap metal that contains cobalt. Among its many uses are in the manufacture of hard-metal alloys (in combination with tungsten carbide), blue-colored pigments, and fertilizers. Cobalt is added to some paints and to porcelain enamel for use on steel bathroom fixtures, large appliances, and kitchenware. Cobalt carbonyls are used as catalysts in the synthesis of polyester and other materials. Small amounts of cobalt naturally occur in food; vitamin B_{12} is a cobalt-containing compound that is essential to good health.

Cobalt occurs naturally in dust, seawater, and many types of soil. It is also emitted into the environment from burning coal and oil and from car and truck exhaust. Usual human exposure is from food sources. Exposure in the workplace may come from electroplating, the processing of alloys, or the grinding of tungsten carbide-type metal-cutting tools. Workplace standards for external air exposure to cobalt and several of its com-

Table 11. Cobalt

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 years and older, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6 and older	.372 (.347-.399)	.130 (.110-.140)	.220 (.200-.250)	.400 (.370-.420)	.630 (.580-.660)	.940 (.880-1.06)	1.32 (1.16-1.45)	2465
Age group								
6-11 years	.498 (.438-.565)	.220 (.150-.320)	.350 (.280-.430)	.520 (.450-.580)	.740 (.640-.850)	1.03 (.860-1.12)	1.22 (1.03-1.50)	340
12-19 years	.517 (.466-.574)	.200 (.170-.250)	.350 (.290-.390)	.520 (.490-.540)	.810 (.670-.870)	1.16 (1.01-1.47)	1.52 (1.24-2.57)	719
20 years and older	.339 (.313-.368)	.120 (.100-.130)	.200 (.180-.230)	.360 (.330-.400)	.560 (.520-.630)	.880 (.790-.970)	1.28 (1.06-1.45)	1406
Gender								
Males	.369 (.342-.398)	.150 (.120-.170)	.230 (.210-.280)	.400 (.380-.420)	.580 (.540-.630)	.810 (.750-.880)	1.01 (.910-1.12)	1227
Females	.375 (.340-.415)	.120 (.100-.140)	.220 (.180-.240)	.410 (.350-.440)	.670 (.600-.750)	1.17 (.970-1.34)	1.49 (1.28-1.98)	1238
Race/ethnicity								
Mexican Americans	.415 (.370-.466)	.130 (.100-.180)	.250 (.220-.310)	.470 (.400-.510)	.660 (.630-.740)	1.05 (.930-1.22)	1.47 (1.25-1.61)	884
Non-Hispanic blacks	.433 (.401-.467)	.160 (.140-.190)	.270 (.240-.290)	.420 (.390-.470)	.680 (.610-.780)	1.15 (1.02-1.25)	1.45 (1.22-2.04)	568
Non-Hispanic whites	.365 (.332-.402)	.120 (.090-.130)	.220 (.190-.260)	.400 (.350-.430)	.620 (.560-.670)	.930 (.840-1.06)	1.29 (1.06-1.49)	822

pounds have been established (OSHA, ACGIH). Pneumoconiosis, asthma, contact dermatitis, and cardiomyopathy have occurred following chronic, high-level exposures in the workplace or as a result of chronic unintentional exposures. A mild reduction in thyroid function was noted in one worker study (Swennen et al., 1993). Cobalt is considered an animal carcinogen, but evidence of its carcinogenicity in people is inadequate (IARC). Information about external exposure (environmental levels) and health effects is available from ATSDR at http://www.atsdr.cdc.gov/toxprofiles.

Interpreting Urine Cobalt Levels Reported in the Tables

Urine cobalt levels were measured in a subsample of NHANES participants aged 6 years and older. Subsamples were randomly selected within the specified age range to be a representative sample of the U.S. population. Measuring cobalt at these levels in urine is possible because of advances in analytical chemistry. Finding a measurable amount of cobalt in urine does not mean that the level of cobalt causes an adverse health effect.

For workers exposed to cobalt in the air, the distinction between soluble cobalt and insoluble (oxides and metallic) cobalt should be made (Christensen and Poulsen, 1994; Lison et al., 1994). Exposure to soluble cobalt salts will produce proportionately higher urinary levels because of better absorption. The ACGIH BEI is 15 µg/L at a threshold limit value (as a time-weighted

Table 12. Cobalt (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 years and older, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6 and older	.350 (.328-.374)	.162 (.147-.175)	.224 (.210-.236)	.326 (.307-.355)	.507 (.471-.561)	.821 (.723-.913)	1.16 (.955-1.41)	2465
Age group								
6-11 years	.546 (.487-.611)	.287 (.256-.322)	.391 (.338-.436)	.548 (.471-.625)	.774 (.629-.938)	1.00 (.833-1.48)	1.23 (.895-1.50)	340
12-19 years	.390 (.353-.430)	.176 (.165-.189)	.259 (.227-.284)	.374 (.330-.397)	.535 (.469-.586)	.824 (.640-1.10)	1.44 (.805-3.54)	719
20 years and older	.325 (.302-.350)	.152 (.138-.170)	.211 (.193-.226)	.302 (.278-.324)	.465 (.431-.500)	.727 (.667-.861)	1.12 (.913-1.30)	1406
Gender								
Males	.288 (.268-.309)	.139 (.120-.156)	.191 (.176-.214)	.277 (.256-.294)	.400 (.375-.436)	.608 (.545-.706)	.833 (.679-1.05)	1227
Females	.422 (.389-.457)	.190 (.180-.211)	.262 (.238-.289)	.405 (.366-.443)	.605 (.561-.667)	.955 (.861-1.16)	1.50 (1.14-1.64)	1238
Race/ethnicity								
Mexican Americans	.383 (.346-.424)	.163 (.134-.205)	.246 (.212-.280)	.376 (.342-.409)	.598 (.510-.656)	.898 (.786-1.01)	1.23 (1.11-1.35)	884
Non-Hispanic blacks	.281 (.265-.299)	.122 (.113-.139)	.174 (.163-.201)	.254 (.238-.280)	.417 (.375-.467)	.707 (.604-.774)	.975 (.757-1.45)	568
Non-Hispanic whites	.366 (.335-.399)	.172 (.150-.187)	.234 (.211-.256)	.344 (.314-.378)	.520 (.468-.586)	.861 (.721-.972)	1.25 (.957-1.50)	822

average) of air exposure at 20 μg/m^3 and applies only to exposures from soluble forms of cobalt. Correlations between air-exposure levels and urinary cobalt levels in hard-metal fabricators are well documented (Ichikawa et al., 1985; Linnainmaa and Kiilunen, 1997; ACGIH 2001; Kraus et al., 2001; Lauwerys and Hoet, 2001). Air and urine cobalt levels for the workplace have been set as parallel standards in Germany. For instance, a urinary level of 30 μg/L can result from exposure to 0.05 mg /m^3 in the air. Generally, workers have urinary concentrations several to many times higher than general populations. Swennen et al. (1993) reported a median value of 44 μg/gram creatinine and a maximum value of 2,245 μg/gram creatinine in cobalt workers. The 95th percentiles of urinary cobalt levels reported for this NHANES 1999-2000 subsample are much less than levels observed during occupational exposures or established occupational levels of concern.

Previous studies reporting urinary levels for general populations in other developed countries have found values roughly similar to those reported in Tables 11 and 12 (White et al., 1998; Minoia, 1990; Lauwerys and Hoet 2001). In addition, levels measured in clinically submitted specimens are also broadly similar (Komaromy-Hiller et al., 2000) to levels documented in this *Report*. A previous study of urinary metals in a non-random subsample from NHANES III participants found several-fold higher values of cobalt, which are likely due to methodologic differences (Paschal et al., 1998). Because concentrations of cobalt in the urine decline rapidly within 24 hours after an exposure ceases (Alexandersson et al., 1988), such measurements reflect recent exposure. Taking multivitamins, tobacco smoking, and the presence of metal joint prostheses may increase cobalt excretion in the urine.

Geometric mean levels of the demographic groups were compared after adjustment for the covariates of race/ethnicity, age, gender, and urinary creatinine. Urinary cobalt levels were slightly higher for ages 6-11 years than for ages 12-19 years, with both age groups having higher levels than people in the 20 years and older age group. Urinary cobalt levels in females were higher than in males, and levels in non-Hispanic blacks were lower than in either Mexican Americans or non-Hispanic whites. It is unknown whether differences between ages, genders, or races/ethnicities represent differences in exposure, body-size relationships, or metabolism.

Whether cobalt at the levels reported here is a cause for health concern is not yet known; more research is needed. These data provide physicians with a reference range so that they can determine whether people have been exposed to higher levels of cobalt than those found in the general population. These data will also help scientists plan and conduct research about cobalt exposure and health effects.